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# Sustainability: What Does it Mean for the Operations Manager?

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*ABSTRACT:* This study discusses the broad concept of sustainability using several viewpoints to identify the best approach to adopt it in business operations. Starting from the grand perspective adopted by the United Nations and other governmental organizations, it presents sustainability as a business policy grounded on the triple bottom line. Performance measures and continuous improvement are introduced as the components necessary to translate sustainable corporate strategy into sustainable operations, using an integrated quality, environmental and safety management system.

*KEYWORDS:* sustainable policy, environmental management, total quality management, safety management, continuous improvement

## INTRODUCTION

The term sustainability has been used extensively in recent years. For example, during the financial crisis that led the US automakers to request financial rescue, President-elect Barack Obama stated that a bailout should be provided as part of a long-term plan for a "sustainable U.S. auto industry." Politicians, journalists and concerned citizens repeated variations of this claim, but it was never clear if everyone gave the same meaning to the phrase, which begs the question: How do you define a sustainable auto industry? Broadly, what does sustainability really mean? Can it be defined in a way that leads to actionable decisions?

The generally accepted definition of sustainable development is "*…development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" (United Nations 1987). Since then, several have used variations of this sentence to define sustainability. That includes the US EPA, signatories of various environmental meetings such as the Rio Summit 1992, and a few academics concerned with the state of the natural environment. There is a reason for generally accepting this definition: its simplicity is inspiring, and it can help politicians and organizational leaders to forge long-term policies in a society that usually prefers immediate results.

In 1999, in the World Economic Forum in Davos, Switzerland, the Secretary-General of the United Nations proposed a Global Compact to "give a human face to the global market." It directed business leaders "to embrace, support and enact a set of core values in the areas of human rights, labor standards, and environmental practices." (United Nations 1999) These three areas were selected because they were within the realm of capabilities of business leaders. While managing their investments and operations in countries with various degrees of legislative development, they should make the effort to adopt the highest human rights, labor standards and environmental practices. They should hold their business partners to these same standards. The secretary-general suggested the following set of corporate practices:

1. Uphold and respect human rights.
2. Be pro-active protecting employees' freedom of association and the right of collective bargaining.
3. Ensure that under-age children and forced labor are not part of workforce.
4. Adopt hiring and firing policies that do not discriminate on grounds of race, creed, gender or ethnic origin.

5. Undertake initiatives to promote greater environmental responsibility.
6. Encourage the development and diffusion of environmentally friendly technologies.

The Global Compact has a major human component. In addition to adopting these practices, corporations should require that subcontractors adopt them, even in places where they are not generally enforced. Considering the broad reach of the multinational enterprises, and their impact as leaders in the diffusion of advanced business practices, this compact could be a successful instrument of change, especially in competitive labor markets.

Business leaders have to be concerned with their short-term financial performance in their pursuit for long-term survival. The Global Compact and the UN definition of sustainability are inspiring. However, it is particularly difficult to bridge the concern for "not compromising the ability of future generations to meet their own needs," a bold statement, with the daily needs of competing in a fierce marketplace, meeting customer demands for quality products and services, maintaining a solid credit with bankers, and satisfying the profit expectations from short-term investors. Any and all of these stakeholders react quickly, punishing the firm one way or another, whenever business results disappoint.

This essay tries to bridge this gap. It discusses some of the frameworks that have been used to describe sustainable activities, and it proposes an approach for introducing sustainability in everyday business processes. We first discuss the original sustainability concept, as it concerns most investors and business leaders. Next we turn to sustainability as business strategists have discussed in the last 15 years. Given that many operation and logistic concepts originate from military science, we then discuss sustainability from a military viewpoint. Finally, we operationalize these views into a framework that can be useful for daily operations in a commercial enterprise.

## THE ORIGINAL BUSINESS APPROACH

In the last two decades, the qualifier *sustainable* has expanded its meaning. For example, the New York Times article in 1992 announcing Texas Instrument's sale of its computer activities to Hewlett-Packard included this statement by John White, then president of Texas Instruments' Information Technology Group (New York Times 1992):

> *"The sale is consistent with T.I.'s strategy to concentrate our investment and emphasis on software productivity tools … as well as on hardware where we have a sustainable competitive advantage."*

Earlier business discourse indicated that firms had to adopt a *sustainable business strategy*. Back then, sustainable competitive advantage had a strict meaning: a strategy that is financially and strategically sound, and cannot be replicated or imitated in the market that the firm operates. This meant that the firm would not be concerned just with quarterly results. Rather, managers were expected to adopt policies that would ensure long-term financial success of the company. That approach to sustainability is still used today in financial circles, as exemplified by Tom Rozycki, *Principal MidCap Blend* mutual fund manager, who looks to buy stocks of companies that have a sustainable competitive advantage (Mamudi 2008). The article introducing Rozycki's investment strategy characterizes such a company as having a "sufficient size or market share that it can be relied on to sustain its growth because it has a dominant position in its sector -- a useful trait in increasingly hard times." Furthermore, investing in renewable energy companies is ostensibly described as not sustainable, given that it depends on governmental support. Clearly, this definition of sustainability aligns well with the understanding of what is long or short term for most investors. It provides important advantages, shown in Table 1.

Defining sustainability in financial terms is inevitable. For investors, short term is measured in quarters, and long term is measured in years. Publicly traded corporations are required to produce periodic financial reports that are highly regulated. They provide some level of transparency that allows evaluating their short-term economic performance, measuring its evolution over time, and comparing it with the performance of other corporations. However, this definition is uni-dimensional: according to this approach, only measures of economic performance matter. Moreover, what is most disturbing, there seems to be a significant inconsistency between short-term and long-term performance. Frequently we observe firms performing poorly when recently they were performing well, and vice-versa. This begs the question: Do the quarterly financial reports actually reflect the long-term sustainability of the corporation?

**Table 1: Characteristics of the traditional definition of sustainability**

| Advantages | Limitations |
|---|---|
| • Easy to understand<br>• Easy to compare<br>  ○ Across periods<br>  ○ Across organizations | • Uni-dimensional<br>• Low correlation with long-term performance |

The financial perspective does not align well with what constitutes sustainability for the United Nations. As an inter-governmental organization, it can afford to introduce sustainability in broad terms that conjure very long-term environmental protection. For the United Nations (and for policy makers), short term is measured in years, and long term is measured in generations. Hence, quarterly reporting – financial or otherwise – cannot possibly indicate whether an organization is sustainable or not.

Corporations have to pursue business strategies that ensure success in what constitutes a very competitive scenario. If the company is publicly traded, this need for success constitutes a legal obligation, and managers are expected to maximize shareholders' profit. A financial analyst has to identify companies that adopt sustainable business practices, according to the time frame stipulated by investors, which rarely exceeds a few years. With this in mind, any performance that is not measured using the balance sheet, the income statement, or the statement of cash flow has little relevance in the analyst's selection process. In the absence of governmental regulation that would make specific demands for environmental protection, the manager has to be careful when incorporating environmental sustainability goals into its business strategy.

Corporate policies that enhance long-term performance are not useful if they compromise the firm's ability to overcome short-term hurdles. An unsystematic approach to environmental protection might lead to short term losses that ultimately compromise the future of the firm. Therefore, it is advisable that firms adopting sustainable policies consider their impact on immediate financial success.

## STRATEGIC CONCERN FOR COMMUNITY INTEGRATION – THE TRIPLE BOTTOM LINE

Stuart Hart proposed another framework of corporate strategy based on how the firm can augment shareholder value while adopting sustainable business strategies, (Hart, Beyond Greening: Strategies for a Sustainable World 1997), (Prahalad and Hart 2002), (Hart and Milstein, Creating sustainable value 2003). The framework indicates four distinct approaches to address corporate social responsibility, whether the firm seeks internal or external opportunities, and whether these opportunities envision future or current objectives, shown in Figure 1.

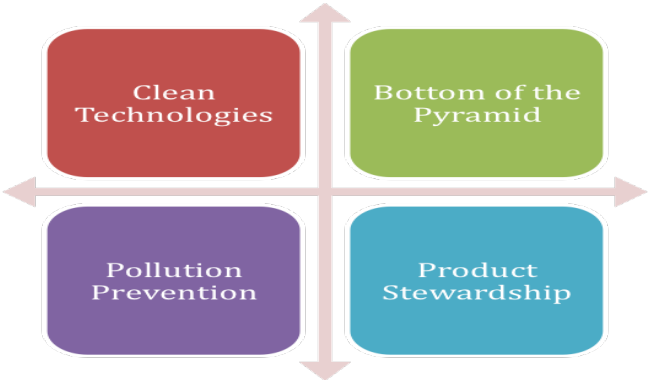


**Figure 1: Hart's *Sustainable Business Strategies***

**Clean technology** strategy refers to the development or adoption of new technologies that may have a long-term payoff. These technologies address internal issues, rather than meeting a new market need. They address inefficiencies in the established processes, typically requiring fewer raw materials, less energy or both. It also indicates that the new technology differs from current practices by avoiding the use of materials that are toxic or in limited supplies. An example of clean technology strategy is the major investment in wind energy by some utility companies, which does not need the constant

supply of fossil fuels, as it would be required in a typical power plant.

**Pollution prevention** strategy focuses on present and internal performance measures, such as cost and risk reduction. It indicates that the firm has taken measures to incorporate pollution prevention or reduction technologies, without major modifications in the operating process. This approach is usually effective in delivering immediate financial results, but it is no guarantee that the firm is well positioned to face competitive pressures in the future. The adoption of water treatments, sound barriers, air cleaners and other pollution reduction artifices in a production environment, whether it is beyond or just meeting compliance, are examples of pollution prevention strategies. The highly advanced Trent turbine developed by Rolls-Royce is considered one of the quietest and most fuel efficient turbines in the civil aerospace market. By focusing on internal performance measures – fuel efficiency and noise reduction – Rolls-Royce supports a corporate strategy of pollution prevention.

**Product stewardship** strategy refers to the modification of current business practices by taking long-term responsibility over the products offered to the public. The qualifier here is "stewardship", indicating that the firm keeps track of the used product throughout its useful life, implementing a reverse logistics process that includes collection, recycling and remanufacturing operations. A classic example is Xerox and its lease programs: for many years Xerox would lease photocopy machines to all its customers, collect them once the contracts were not renewed, and proceed with an extensive remanufacturing process, often requiring some upgrade, to reposition the product in the market as good as new. This approach served Xerox well for more than two decades, but some critics question whether this reliance on existing technology may have prevented the company to invest more aggressively in digital imaging technology to remain market leader.

**Bottom of the pyramid** is the boldest approach to the implementation of a sustainable strategy, focusing on a long-term vision for global sustainability, while reaching out to markets that have been neglected by most competitors. Sometimes this strategy has been executed using simple existing technologies under highly innovative organizational structure, such as the Grameen Bank Ltd. in Bangladesh. In a society where poor women are generally shunned by traditional financial institutions, Grameen is specialized in providing micro-loans to this particular market, while turning a profit in 22 of the last 25 years.[1] It started in 1976 with 10 members (clients), and it boasted 7.3 million members in 2007, of which 96% were women.

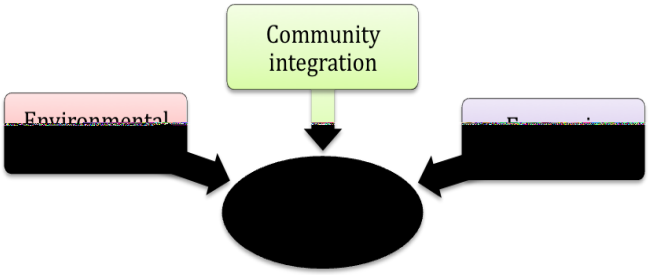


**Figure 2: Economy-Environment-Community Strategic Triad**

The "bottom of the pyramid" strategy recognizes that two-thirds of the human population lives on a per-capita income lower than $1,500 per year. These individuals are consumers who would like to have access to quality goods and services as the rest of the population does. To deliver this strategy, some products need to be reinvented to be affordable to the bottom of the pyramid. This is the case of the One Laptop Per Child (OLPC) organization, proponents of an affordable laptop that can be used by school children in every community.2 Its laptops are characterized by rugged child-friendly construction, networked, using simple open-sourced software and sold at a low price (although its initial target of $100 has been abandoned). OLPC is still in its infancy. It is not yet financially sustainable yet, and it has as many friends as it has opponents. Its survival currently depends on the support of charity and government purchases. However, whether the project succeeds or not, it indicates a "bottom of the pyramid" strategic vision of its founders, by designing and adapting a product typically associated with the wealthy-urban-professional environment (the laptop) to the poor-rural-student consumer who would greatly benefit from the educational opportunities that the laptop may provide.

1 Source: http://www.grameen-info.org/
2. Source: http://laptop.org/en/index.shtml

**Table 2: Characteristics of the Economy-Environment-Community Strategic Triad**

| Advantages | Limitations |
|---|---|
| • It is multi-dimensional<br>• It incorporates the human side of the equation<br>• It helps establishing partnerships with governmental and non-governmental organizations | • There is limited synergy between the three dimensions<br>• It is difficult to incorporate in the productive process<br>• It is difficult to measure performance |

The bottom of the pyramid approach to sustainability is based on the triple-bottom-line of the economy-environment-community triad (Figure 2). It presumes that the business strategy is sustainable if, while ensuring long-term financial success of the organization, the business is a guardian of the environment, and a patron of the community where it operates. Table 2 shows its strengths and weaknesses. The most notable aspect is the human element, which until recently was not included in the sustainability discussions. Recall the UN sustainability definition of 1987: the concern was restricted to the environment. By that definition, future generations appeared as users of the wealth derived from the environment, not as fragile elements that need protection. The 4 billion individuals in the bottom of the economic pyramid were only recognized in more recent discussions, as potential consumers that need to be included in all sustainable business strategies. As consumers, they are stakeholders. Hence, it is important for businesses to consider their sustainability as well.

Another interesting aspect of the economy-environment-community triad: it is multi-dimensional. This makes its implementation complex, but it prevents focusing on a single issue (such as financial performance). So, the senior manager has to make decisions considering the impacts in three distinct areas that are not obviously related and may have conflicting interests. The human aspect also has the benefit of bringing the potential support of external organizations. The most problematic aspect is the challenge of designing a set of performance measures that accurately reflect the organization's progress toward triple-bottom-line sustainability, and that relate to its financial performance.

In its 2000 environmental report, Baxter, a manufacturer of health-related products, indicated that it was adopting a sustainable business strategy, with a focus on reducing environmental impact, introducing a bioethics policy and reducing toxics emission. It indicated that incorporating sustainability concepts in its strategy could offer the following opportunities (Whiting and Bennett 2001):

- Reducing waste and boosting safety, thereby increasing productivity
- Building brand strength and corporate reputation
- Enhancing recruiting by making a company a more desirable place to work
- Attracting capital from investors who work only with socially responsible companies
- Enabling better risk management
- Encouraging innovation
- Helping secure public approval for global expansion and free trade

All of these are valid objectives, and many of them can be realized if the company executes this strategy. However, the relationship between these opportunities and a sustainability strategy is not always obvious. For example, how do you transform a new bioethics policy into greater innovation, free-trade expansion, or stronger brand? Or, how do you convert a reduction in toxics emission into increased productivity, or better access to capital?

As Harry M. Jansen Kraemer, Jr., Chairman and CEO of Baxter indicated, the firm must be prudent. "No company can survive to continue its efforts toward sustainability if it does not also exercise sound business judgment. Sustainability must also sustain the company." (Whiting and Bennett 2001) It is important to introduce a framework that converts business strategies focused on the economy-environment-community triad into implementable operational decisions.

## THE MILITARY APPROACH TO SUSTAINABILITY

In military operations, as in most governmental operations, profit is not an objective. Sustainability is not bound by the financial concerns that are expected from private entities; however, military institutions, as well as any governmental or not-for-profit entity, have short-term cost constraints that affect how they may adopt long-term policies.

Military sustainability, or *sustainment*, refers to all activities related to logistics support throughout the life cycle of acquired equipment. Transportation, logistics and maintenance play a significant role in providing sustainment, given that once equipment is shipped from manufacturer to user, it may be transported several times to field operation sites and back, being subject to substantial physical stress. After years of use, all equipment is scheduled for remanufacturing, until they eventually are discarded.

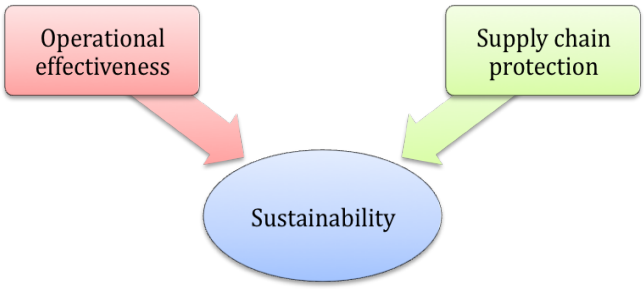


**Figure 3: Military Sustainability (Sustainment)**

According to the US Dept of Defense, "sustainment includes supply, maintenance, transportation, sustaining engineering, data management, configuration management, manpower, personnel, training, habitability, survivability, environment, safety (including explosives safety), occupational health, protection of critical program information, anti-tamper provisions, and information technology (IT), including National Security Systems (NSS), supportability and interoperability functions (Defense Acquisition University 2004)." Hence, military sustainability is concerned with providing the logistic support so that the military operation can sustain itself until fully executed, as shown in the chart below:

**Table 3: Characteristics of Military Sustainability (Sustainment)**

| Advantages | Limitations |
|---|---|
| • Easy to understand<br>• Measurable performance<br>• Life-cycle approach | • Concerned exclusively with logistics<br>• Focus on operation execution |

The sustainment definition includes several human variables (training, survivability, occupational health, safety), as they are ingrained in the US military philosophy. These and other objectives make sustainment easy to understand and adopt, albeit being complex. Moreover, many of its objectives include measurable performance metrics that can be controlled if desired. However, its focus remains on producing the logistics that ensure effective operational execution. For the commercial enterprise this would be the equivalent to focusing all effort in supporting operations that generate on-time delivery to all customers, while maintaining acceptable health and safety performance. The enterprise adopting military-style sustainability would have reliable supply, maintenance and data management. Because of the narrow focus, it is not the best way to incorporate multi-dimensional sustainable business strategies based on the economy-environment-community strategic triad. We discuss an alternative in what follows.

## MEASURING SUSTAINABILITY

Over the years, the concept of sustainability concept has expanded to incorporate broader aspects of the firm's fitness to compete in the present and in the future, considering its financial and operational performance, with specific focus on its impact on the environment. Sustainability has taken a different meaning in the minds of most executives; it is often associated with environmental protection, the use of clean technologies or the adoption of renewable energy sources. In the language of economists, it suggests the objective of maximizing value added per unit resource input. This idea is equivalent to maximizing *resource productivity* at the firm level while taking into account scarce environmental resources as well as energy and raw materials, rather than simply minimizing wastes or pollution associated with a given product. Ayres, Ferrer and Leynseele (1997) suggested an approach emphasizing the reduction consumption of material and energy, recyclability, and the expansion of product durability. The approach is elaborated below:

1. Minimize the material intensity of goods and services. Manufacturing organizations should strive to reduce the amount of material used to make the product, and the amount of supplies needed to use the product. Products should require less material to be maintained. Service organizations should strive to consume less material in delivering their services.

2. Minimize the energy intensity of goods and services. Manufacturing organizations should reduce the energy needed to make, to use, and to maintain the product. Service organizations should consume less energy in delivering their services.

3. Minimize toxic dispersion. Manufacturing organizations should reduce the amount of toxics dispersed while making, using or maintaining the product. Service organizations should reduce the amount of toxics dispersed while delivering their services.

4. Enhance material recyclability. Product designers should adopt raw materials that facilitate product recycling.

5. Maximize sustainable use of renewable resources. Product designers should prefer materials and supplies generated using renewable resources. Commodity and raw material producers should strive to increase the sustainability of their sources.

6. Extend product durability. Product designers should strive to increase the useful life of the product.

7. Increase the service intensity of goods and services. This is the dual of the first objective in that increasing service intensity naturally reduces material intensity of the product. Also, manufacturers should strive to increase the service content of their products, to the extent that it increases the value to the customers.

These seven objectives have a strong product design and engineering focus. The US OTA also released an extensive report on this matter with recommendations to engineers (Office of Technology Assessment 1992). Other recommendations for sustainable product design are found in Anastas and Zimmerman (2003) and in McDonough, et al. (2003).

However, from a management standpoint, there seem to be three key objectives that must not be forgotten by the manager wishing to integrate sustainability in its operations:

1. The organization must provide real services based on customer's needs.

2. The operations must support the organization's economic viability.

3. The organization bears responsibility regarding the environment in which it operates.

With these elements in mind, the operations must adopt a systems (life-cycle) viewpoint to both processes and products. These elements remain firmly in the domain of corporate management. For this reason, sustainability has found space in many executive lounges with the appointment of senior managers holding titles that include the term *environment* or *sustainability*, clearly indicating their responsibility. For example, General Electric recently created an organization called Ecomagination, focused on identifying environmentally conscious products in the corporation and giving them appropriate support to achieve healthy results (LaMonica 2007). Ecomagination itself is not a division, but a corporate initiative that promotes green design in all of GE's divisions, accounting for more than $20B in annual revenues. The success of such a blanket initiative, impacts the entire corporation, and it re-

quires integrating the "green" concept in the corporate strategy, without losing sight of the operational efficiency, commercial appeal and financial strength of each business unit. As we observe in this example, we must think about *sustainable operations* as the implementation of sustainable business strategies.

In September 2000, the Millennium Declaration was adopted at the 55th session of the UN General Assembly held at United Nations Headquarters in New York (United Nations 2008). The seventh goal in the declaration is to ensure environmental sustainability. An interesting feature of the Millennium Development Goals is the adoption of 20 targets (four of them associated with environmental sustainability) all of them integrating one or more performance measure. These targets specify levels of improvement and expected success dates. Sustainability is no longer an abstract concept, but a measurable target upon which society can improve. With the Millennium Declaration, the United Nations recognizes the importance of measuring and recording performance towards achieving results, in the same way that has been proposed by Prof. Deming in his PDCA quality improvement cycle. Likewise, organizations should adopt measurable sustainability objectives.

## PROCESS IMPROVEMENT AND SUSTAINABILITY

Statistics expert Walter Shewhart first conceived the PDCA cycle in the 1920s. Perhaps the earliest continuous improvement tool, it was later popularized by Edward Deming into a virtuous circle (Figure 4), as follows: The manager first PLANS the change, analyzing and predicting results; she DOES (or implements) the change in a controlled environment; she CHECKS (or measures) the performance, verifying how it meets or differs from expected results; and using the latest observation, she ACTS upon it, adopting the process changes that led to improvement. The cycle never stops as the manager continuously develops a new plan for further improvement. Perhaps the most important contribution of the PDCA cycle to process improvement is that it incorporates a systematic measurement of process change.

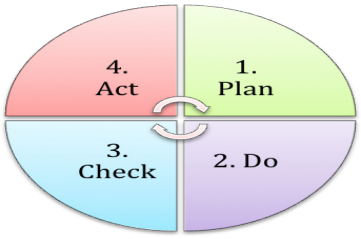


**Figure 4: Deming's PDCA Cycle**

Once the PDCA cycle is adopted, it becomes a useful framework to help the organization continuously improve all its critical processes.

Over the years, several process measurement tools have been developed and adopted by organizations concerned with protecting or improving their processes. Those tools can be qualitative – generally used to understand the variables affecting process performance. The tools can also be quantitative – generally used to measure process performance or variation from target performance.

Without measurement there is no improvement; therefore, in the first phase of the PDCA framework, PLAN, the manager uses a combination of qualitative and quantitative tools that help explain what variables affect the process and in what order they interfere with the process performance. The change is tested in a controlled environment in the second phase, DO. A combination of quantitative tools is used in the third phase, CHECK, to verify if the performance improvement meets expectation. The final phase, ACT, refers to the deployment of the successful improvement.

Leading organizations have realized that the PDCA framework and the process improvement tools can be used not just to improve quality, but they can be used to improve all aspects of the process, including any measurable sustainability objective in the business process.

## INTEGRATING SUSTAINABILITY IN THE BUSINESS OPERATIONS

It is the mission of the production manager to operationalize the organizational strategy! Hence, the production manager can only achieve sustainability if he adopts a continuous improvement philosophy with measurable performance objectives. To operationalize the economy-environment-community triad, the operations manager should integrate the following initiatives as one (Figure 5):

- Total quality of product and process,
- Environmental protection, and
- Total process safety

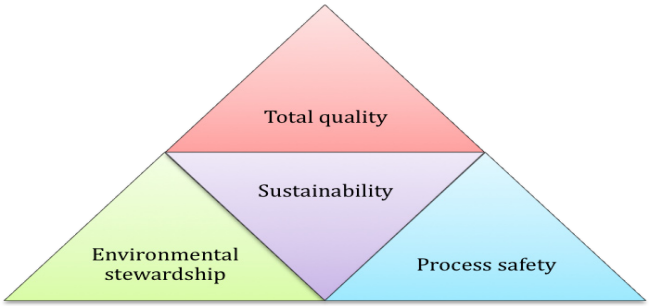


**Figure 5: Components of Sustainable Operations**

The integration of these activities brings together three important sources of non-conformance that can be measured using the same process improvement tools. Whenever any of these activities are non-conformant, operating costs rise substantially. This affects the organization's economic performance. Also, non-conformance in any of these areas increases the amount of waste that is generated, which affects the environmental performance. Finally, both environmental or safety non-conformances place the workforce in jeopardy, impacting him- or herself and respective family. Thus, non-conformance in these areas affects the community in multiple ways. To operationalize the organization's sustainable strategy, the operations manager must integrate quality, environmental and safety management and strive to eliminate all non-conformances with the adoption of continuous process improvement. The following cases illustrate.

## BRASILAMARRAS

Brasilamarras is a small manufacturing company specialized in the production of mooring lines and steel chains for the ship making and offshore petroleum industry. From its location off Rio de Janeiro Bay, one can see offshore drilling rigs being fabricated and assembled in the shipyards. Its offices display several trophies and awards that recognize the excellence of its management systems.

Brasilamarras has been in business since 1978. Its first effort to export to the European market was faced with skepticism. Most potential customers questioned whether the young Brazilian company would be able to deliver their orders. After a presentation in an international trade show, the company's director was confronted with the question: "Can you deliver?" Rather than dwelling on the defeat, the firm decided to invest in its credibility.

Top management embraced total quality management at a time when TQM was only discussed in academic circles. When the ISO 9000-series was published in 1986, Brasilamarras was one of the first 20 companies worldwide to become certified. This certification was subsequently confirmed by several international organizations, including the prestigious Det Norske Veritas.

The company maintains a pragmatic attitude regarding its certifications. Brasilamarras has six major competitors in the international market, and it strives to obtain all major product and process certifications, but it is concerned with how much these certifications add value to their operations. For example, their quality system is re-certified every three years.

In 1997, Brasilamarras was one of the first Brazilian firms to certify its environmental management systems according to the ISO 14001 standard. It was a continuation of their corporate strategy to build and retain market credibility. In order to meet environmental objectives, industrial fuel and electricity consumption have been monitored to help identify opportunities for process improvement. They also instituted a steel chain remanufacturing line to recover ruptured chains. In addition, the firm awarded a productivity prize for shop floor workers based on their input/output efficiency.

More recently, Brasilamarras was certified according to the norm OHSAS-18001, the occupational, health and safety management system designed to complement the ISO standards. These efforts culminated with their receiving international recognition of quality and efficiency, despite having less than 100 employees in the workforce.

Some of the benefits that the firm enjoyed include: less frequent visits from the officers in the State's environmental agency; complete elimination of all environmentally-related fines; lower operating cost due to the reduction of raw materials and utilities; greater worker loyalty and productivity. These benefits allow smooth operations that ultimately increase productivity and reduce cost.

Most suppliers are many times larger than Brasilamarras. Yet, the firm is capable of influencing key suppliers to adopt better operating practices. For example, Brasilamarras utilizes liquefied petroleum gas (LPG) as the main source of heat in its operations. Typically, LPG is vaporized before consumption using a small electric heater at the end of the tank. Instead, the firm made small changes to the

gas line at the end of the tank to facilitate the heat transfer between the surrounding environment and the liquid gas in the line. This simple change saved a significant amount of electricity and maintenance cost of the LPG tank. The LPG supplier, a major gas and oil company, now showcases this solution among all customers as a safe and economical way to use their product.

The firm is also a consumer of oxygen and acetylene, which are delivered in pressurized tanks. They monitored and recorded the delivery process and identified practices that could be a safety liability for their supplier. Upon their recommendation, the acetylene supplier, a major producer of gas products, invested in new equipment that safely handles and delivers their products. With creativity and persistency, the firm has been successful in extending operating practices to its suppliers, helping them become more sustainable.

**COPESUL**

Early in the 1970s the people in Porto Alegre, Brazil, were informed that a petrochemical complex with several inter-related production facilities would be built not too far from the metropolitan area, creating thousands of jobs. Much to the surprise of the investors, which included Brazil's oil and gas giant, Petrobras, the community was less than delighted with the perspective of having as neighbor an industry that is associated with polluting water and air. A marketing campaign reinforced by the slogan "*O Pólo Não Polui*" (The Complex Does Not Pollute) slowly changed public opinion. It helped pave the way to the development of the petrochemical complex in an area of 3,600 ha (approx. 9,000 acres), half of it preserved as an environmental sanctuary. The managers in the new complex kept the promise made in the campaign to run a clean operation.

Copesul was created as the main refinery of the complex, generating the inputs needed in the rubber and plastic plants next to it. Copesul was created "different from other companies" in the way that it relates to the environment. The company adopted sustainable measures long before regulations required, even before the creation of the State's environmental agency. Their foresight, including the pollution prevention equipment in the plant's original design, had a positive impact on the company's finances. "The cost of these investments is 7 to 10 times higher when they are made after the operations begin," clarified the manager responsible for environmental and safety protection. In his words, "financial gain is not a priority in my capital investments." Despite his approach, his actions show a significant economical foresight considering the payoff of the company's investments.

As a matter of discipline, members of the company do not call any output of their plant a "by-product." They continually invest in the development of processes that eliminate the contaminants in by-products, standardize them and transform them into commercial products with proven market demand.

The incorporation documents say that Copesul cannot release any liquid effluent to any body of water in the region. Hence, when the plant was designed, they were careful to keep separate each type of liquid effluents. Four sources were identified: (1) organic fluids (from the main processes), (2) inorganic fluids (from the refrigeration units), (3) general sewage, and (4) pluvial waters (rain). The main concern with the pluvial water is to keep it clean, free from process contaminants. The plant has a network of drains and ditches to capture the rain. To avoid contamination, a system of valves controls the water flow. The rain that falls over the process tanks are contained until a technician verifies that the water is clean. Finally, all the pluvial water is routed to a set of basins where part of it evaporates, part is absorbed into the ground and the excess pours into the river. To facilitate ground absorption, eucalyptus trees were planted around these basins, each of them with a potential intake of 23 liters (6 gallons) of water per day. The ground absorption is monitored with 40 wells that collect samples twice per year from the aquifer underneath. More problematic is the water contaminated with organic fluids (oil and wax). The water and oil mixture can be biodegradable in "land farms" under certain climatic conditions, but Copesul found that the process is too slow to absorb the amount generated by the plant. The current solution includes separating the contaminants from the water, and burning them with coal, minimizing the amount of water that goes in the land farms.

Copesul uses locally extracted coal as a significant source of energy, as part of its operational agreement with the State. However, the local coal contains sulfur, which generates sulfur oxide when it is burned, one of the main sources of acid rain. The atmospheric releases are monitored with 12 air pollution stations, mostly located downstream from the prevailing direction of the winds. The coal also generates a significant amount of ashes, which would have to

be landfilled. Copesul addressed both problems in a profitable way. The firm centrifuges the coal by separating the fuel from the contaminant. The sulfur that is obtained can be sold as raw material in various markets. In addition, Copesul invested in technology to control the ash composition to a standardized set of criteria. The firm signed a long-term contract with a cement company that manages the ash output. The cement company buys 2000 tons/year of ash at market prices, and incorporates it in the cement composition. This is in agreement with their philosophy that nothing leaves the plant as waste.

During a strategic planning meeting, the suggestion of ISO 14000 certification was met with a "why not?" The perception was that the firm was so advanced in their environmental practices that the effort to obtain the prestigious award would not be excessive. Copesul was already a signatory of the "Responsible Care" chart, so ISO 14000 certification would be little more than a formality. For a meager R$ 120,000 (US$ 40,000), Copesul obtained its ISO 14000 certification. Their EMS manager described the benefits as "fantastic." Now, actions are systematized, and all procedures are documented. In addition, they found that the persistent organic compounds are the main pollutants, and they voluntarily started to monitor them. The firm establishes annual targets of pollution prevention and reduction, and voluntarily provides regular reports to the State's regulatory agency.

The drive to reduce pollution triggered a series of investments, such as the demineralization of used water, the utilization of asphaltene as a source of energy, and the recovery of gasoline vapors in the truck loading stations. Some of these investments had a low expected ROI, but the EMS manager justified: "in our department, we are the guardians of the environment for the firm."

Copesul plant design includes sophisticated environmental protection features that meet the promise made to the community that hosted them. Nonetheless, the firm continues to invest in creative ways to reduce its environmental impact. These process improvements focus on environmental performance, but they often provide superior economic returns.

**GKN AUTOMOTIVE**

GKN is a manufacturer of constant velocity joints: the components that transfer the engine power to the driving wheels of the car. Their Brazilian operation has a plant located in the southern capital, Porto Alegre, and has been supplying to the automobile industry for many years. It is the Brazilian arm of the Automotive Driveline division of GKN, a major manufacturing conglomerate headquartered in the UK. The plant was once part of a joint venture with Brazilian investors and Dana Corp., another automotive component giant. Since the discontinuation of the joint venture in 1997, the Porto Alegre plant, with 1,200 employees, has been under control of GKN plc.

The firm adopted Quality Control back in 1980s. Since then, it went through several stages of enhancement in the quality control systems. It included a suggestion box that rewarded the employer that made the most suggestions of process improvement in the plant, just-in-time using kanbans, and a profit sharing program.

While the joint venture was still in place, Dana required that all plants in South America be ISO 9000 and ISO 14000 certified. The corporation selected these plants to supply the automakers in the European market, and all of them required these certifications from their first tier suppliers. Today, the plant is controlled by GKN plc., and it exports some of its production to Europe and the US, supplies all 12 automakers in Brazil, and holds a 72% market share. By the time the headquarters in UK recognized that all plants should adopt ISO 14000 as part of an effort to contain their environmental liability, the Porto Alegre plant was ready.

When management control switched from Dana to GKN, the firm was in the middle of its ISO 14000 implementation. This delayed the certification significantly, but the results are palpable. The firm monitors energy consumption and has reduced the generation of $CO_2$. Solid waste is separated in several colored bins, indicating the respective recycling stream. All workers in the plant floor are conscious of their environmental responsibility: a quick visual inspection of a set of waste bins showed that the workforce was using them appropriately. Suggestions with positive environmental or safety impact were rewarded in the suggestion box program, and the budget of the environmental management department rose to approximately US$ 150,000/year.

The plant adopted several process improvements, including separation of the metal shavings from the cooling oil in the milling operations and the con-

struction of a liquid effluents treatment station. A major improvement happened in the redesign of several parts used by the firm. The constant velocity joint is an assembly of two axes connected by a casing with a set of gears inside. Usually, these axes and casings come rough from the foundry, requiring several milling steps where metal is removed in several operations until the part meets the specifications required for final assembly. They now come from the foundry forged very close to these specifications. Most of the milling operations remaining are there for esthetic purpose. These changes were crucial in the reduction of electricity and raw material consumption, as well as solid waste and used oils generation.

At all GKN facilities, and this plant is no exception, all new capital investments follow a standardized approval process which includes, in addition to financial and operational benefit, the environmental and safety impact. According to this process, the environmental manager has veto power to reject capital expenditures that do not conform to the environmental management system.

Currently, the plant adopts an Integrated Management System (IMS) that incorporates three areas: Quality (ISO 9000 certified), Environment (ISO 14000 certified), and Occupational Safety, Health and Community Relations (OHSAS 18001 certified), with a coordinator directly reporting to the country manager. The coordinator generates a yearly report with the costs and objectives of the IMS. The country manager in Porto Alegre lends his personal support to these initiatives. Consequently, a recent report from the corporate headquarters in the UK recognized that the plant has the best environmental performance of the group, one of the few with a certified EMS.

The original objective to certify the quality and the environmental management systems was to satisfy the requirements imposed by European customers. Subsequently, the firm was contacted by the automakers in Brazil that these certifications would be one of their requirements as well. At that time, they were ready. Their foresight was important to retain their position in the Brazilian market as well as to penetrate in more demanding international markets.

The firm is proactive in its relationship with the State's environmental agency, sending quarterly report including weekly environmental data of air releases, and water effluents, beyond regulatory requirements. This relationship is important to minimize the occurrence of disruptive inspections to their operations. According to their EMS manager, the firm has ISO 14000 because it is ethically required. They have an obligation to protect the planet from their environmental impact. This message transpires to the media that recognizes the ethical side of the company. This impacted employees' loyalty and commitment to the company's success. It is expected that the workforce applies these values in their daily lives, and become better citizens.

## MATTEL OF THAILAND

On the outskirts of Bangkok lies one of Mattel's manufacturing site, the facility responsible for the production of Hot Wheels best-selling toy cars. It has been part of the Mattel group since 1998 when the corporation absorbed the Matchbox operations and trademark. The Bangkok plant was part of the deal. When the new management team arrived, several changes were necessary to fit the plant to Mattel's culture as well as its quality, environmental and safety standards. As the new management system was introduced, the management team decided to certify them according to the respective international standard. Consequently, the facility in Bangkok is the only Mattel plant worldwide that is certified according to ISO 9001, ISO 14001, and OHSAS 18001.

Mattel has a corporate environmental control department, Global Sustainability, which established environmental, health and safety (EHS) policies that meet or exceed the regulation in all countries where the firm operates. As the CEO puts it, the company must integrate the EHS in everyday business. Individual facilities may adopt different norms, as long as they meet the corporate and the local standards. As a consequence of the certifications, Mattel in Bangkok is subject to an annual audit by the corporate body and independent audits.

The original motivation for the certification was to pass onto the workforce Mattel's commitment to the community where they live and work. For example, they have adopted a poor school in Thailand by building new classrooms, a playground and a library. The corporation has a very conscious community involvement, developing relationship with schools and universities. Moreover, they recognize that good citizenship through environmental responsibility is important for a company that pro-

duces and markets children's products. The company takes care of the workers in different ways, even teaching them practical skills that may or may not be related to their jobs. A significant benefit is the good word-of-mouth among potential workers. Recently, the firm had to close plants in Malaysia and India. Before closing the plants, the corporation assessed the need of ground decontamination before divesting, a concern that is usually not enforced in these locations.

For the managers in Thailand, environmental, health and safety management is a cost saver. For example, a certain process used to require that the worker wore safety masks to protect against chemical fumes. The operation was a health, environmental and safety hazard that was treated with standard safety precautions. The managers decided to examine the operation to better understand the cause of the emissions. A small change in the process eliminated the toxic fumes, providing several economic benefits, in addition to obvious improvements in the EHS performance: the cost of treating the pollution (using masks), as well as the health hazard risk were eliminated. Moreover, the discomfort of wearing a mask disappeared, which allowed measurable increase in productivity.

Since Mattel took control of the plant in Bangkok in 1998, it has been monitoring air, noise, wastewater and heat emissions, in addition to water consumption and workplace lighting. Initially, management identified 180+ non-conformances that had to be corrected. That triggered a plant improvement process in multiple phases. Phase I dealt with the plant survey. Phase II, from 05/2000 to 02/2002, was concerned with identifying the soil, underground water and asbestos contamination. It was found that the previous owners had improperly maintained their stock of diesel oil, creating a significant contamination that had to be treated. Also, it was in this period that the plant obtained the ISO 14001 and OHSAS 18001 certifications by DNV. In Phase III, all contaminated soil was excavated and sent to an incinerator approved by the government. Consequently, the number of non-conformances in the plant had dropped to single digits.

The production of Hot Wheels toy cars requires a small number of raw materials: zinc, for most of the body, shaped in metal casting operations; transparent plastics, for the windshield, shaped in precision plastic molding machines; post-industrial recycled plastics, for the wheels, also shaped in plastic molding machines. Before final assembly, the car bodies are painted according to the respective designs. From an EHS viewpoint, this is an area of great concern because of the volatile organic compounds (VOC), posing significant environmental and fire hazard. Hence, management engaged a series of fire prevention projects, including the installation of fire arrestors, centralized fire alarms and fire doors. Moreover, an automated painting system was acquired to reduce and sometimes eliminate painting fumes, with a 5-year payback. Other process changes included the elimination of hand spray, and the substitution of solvent-based paint to water-based paint; both changes were made to eliminate the emission of toxic fumes.

Management is concerned with keeping employees aware of the environmental, health and safety issues in the plant. The certified standards have helped the plant to introduce and maintain a good citizenship policy towards the employees and the general community in which it operates. The standards prompted process improvement initiatives that improved quality while reducing operational risks.

Human Resources Management plays an important role in the implementation of environmental management practices. A daily quiz with EHS questions rewards two winners each day. Shop floor employees are encouraged to talk freely about their jobs, making suggestions for improvement. A bulletin board posts all suggestions from the EHS suggestion box. It indicates the authors of each suggestion and management's decision to implement or not. Good suggestions are rewarded. If the decision is not to implement the suggestion, there is also a brief justification. The purpose is to maintain the workers involved and to encourage their participation in the process improvement effort. In the first year, the number of suggestions was high. Once the low-hanging fruits were exploited, there have been fewer opportunities for improvement, but they always occur. They facilitate the company's effort to become sustainable.

## THAI WATANA RICE PRODUCTS

TWRP is a small enterprise that produces rice noodles for the export market in Hong-Kong, Australia, United States and Europe. Founded by Mr. and Mrs. Virojanakul in 1975, the firm is now managed by theiwr children. At first glance, the company is the prototypical Thai family business, with each

managerial position taken by a son or daughter of the original founders. However, the company differs from other small or medium enterprises in Thailand with their vision for quality, safety and environmental protection. This vision has improved their competitiveness in the market, earning the status of manufacturers of the premium rice noodle made in Thailand. Since 1996, the managers participated in a number of clean technology seminars sponsored by the Danish government, Thai governmental agencies and local universities. This led to the development of an EMS and the ISO 14001 certification in 1999, the first certification issued to small and medium enterprises in Thailand.

The migration from SE Asia to Western countries increased substantially in the 1980's. Naturally, these immigrants miss some of the goods from their home countries. Consequently, the demand for export-quality rice noodles increased substantially. Thai Watana used this opportunity to expand production while improving the traditional process of manufacturing rice noodles.

The production of rice noodles requires one single raw material, rice. However, the transformation of rice into the spaghetti-looking noodles requires two other inputs: excessive amount of water – to obtain perfectly white rice dough, and heat – to slowly dry the dough to the right humidity for the cutting stage. (See Figure 6). The water used to wash the rice is wasted, carrying soluble and non-soluble solids to the natural streams. Occasionally, the dough does not have the physical properties that allow it to be thinly stretched into a long continuous wafer, about 1.0 mm thick and 0.5 meters wide (3/64 in x 20 in), moving in the drier as a conveyor belt. When the continuous wafer breaks, material is lost (in addition to the value added in the previous stages), creating confusion that takes several hours to correct.

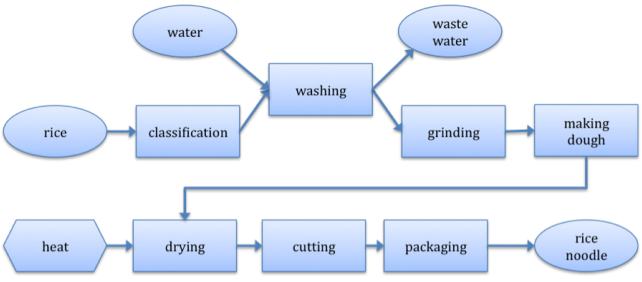


**Figure 6: Material flow at Thai Watana Rice Products**

Before Thai Watana managers ever heard of environmental management systems, they were concerned that their product had to be safe and clean. They had a business responsibility with their consumers and the community in which they operate. Also, the firm was sensitive to the fact that their raw material, rice, is the result of the tiring labor of the Thai farmers, which should be respected. Consequently, they had to modify the process to minimize raw material losses and environmental impact. They engaged in three process modifications, to reduce material losses:

- Introduction of a systematic approach to raw material selection. The firm analyzed the composition of different types of rice to identify which ingredients where responsible for the consistency of the noodle. Having identified the ingredient, they analyze the raw material before purchase, upon delivery and before utilization. Since the adoption of systematic raw material selection, dough sheet breakage was virtually eliminated.

- Waste water recycling. The rice classification process allowed greater control of the washing process, and subsequent reduction in the water consumption, with three notable consequences: (1) reduction of the amount of water used in each washing stage; (2) reduction in the number of washing stages; (3) reutilization of the water used in the final stage into the first stage. Consequently, daily water consumption dropped 75%.

- Reduction of heat loss in drying process. Originally, Thai Watana received regular deliveries of saw dust and wood shavings from a nearby furniture company, free of charge, to use as fuel in the noodle drying oven. Eventually this externality was lost and the furniture company started to charge for its deliveries. The company redesigned its oven and improved insulation, leading to increased utilization of the heat obtained.

For Thai Watana, the greatest benefit of the certification was the increased awareness of the environmental impact of its operation. Since then, non-conformances were identified, quality improved and operating costs were reduced. Process improvement projects led to permanent cost reduction that has had a significant impact in the firm's profitability. The firm continues its quest with plans to recycle the water even further, and to reduce the fly-ash generated by the oven.

## ENVIRONMENT-QUALITY-SAFETY INTEGRATION

These cases presented evidence that the quest for sustainability is a quest for process improvement. All of them show the elimination of non-conformances leading to better processes with lower environmental impact, lower operating costs, increased process standardization or increased workplace safety. Most important, in all cases, was the concerted effort to integrate the environmental, quality and safety management systems into a unified process, with the strengths and weaknesses shown in Table 4.

**Table 4: Characteristics of Environment-Quality-Safety Integration**

| Advantages | Limitations |
|---|---|
| • It is multidimensional.<br>• It is synergistic.<br>• It is measurable.<br>• It facilitates continuous improvement.<br>• It incorporates the human side of the equation. | • It includes just internal processes.<br>• It requires complex coordination.<br>• Operational performance has limited correlation with long-term economic benefit. |

Integrating quality, safety and environmental management systems brings enormous benefits, due to the synergy among them. It requires eliminating non-conformances using a process improvement approach. The low-hanging fruits generally improve performance in more than one dimension. This integration does incorporate the human dimension, through workforce involvement in the improvement of their workplace leading to fewer environmental and safety non-conformances. However, this integration is squarely focused on the internal processes. It requires complex documentation and coordination of process improvement activities to exploit said synergies. Finally, one must realize that operational performance correlates with long-term economic metrics, but no so much with short-term metrics. It is crucial to secure top management support to allow this integration to evolve. Only then, it will mature and support the firm's sustainability strategy, delivering superior triple bottom line performance.

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